ECEN 150 Lab 2 – Breadboards and Resistors

Name:

Purposes:

- Be able to identify resistors using color bands and measure resistance with a multimeter.
- Understand resistor tolerances.
- Learn to use a breadboard.
- Apply resistors in a simple, useful circuit.

Background:

<u>A resistor</u> is a device used to “resist” or reduce the flow of electrical current. Resistance is measured in units of “Ohms” represented by the omega symbol: **Ω**. The schematic symbol for a resistor is this: 

The relationship between current, voltage, and resistance is given by **<u>Ohm’s Law</u>**:

$$\boxed{V=I*R}$$

This law states that the voltage “V” across a resistor “R” is equal to that resistance times the current “I” forced through it. Viewed another way, the current through a resistor is equal to the voltage applied to the resistor divided by the resistance itself: I = V/R. Hence, a larger “R” results in smaller “I”.

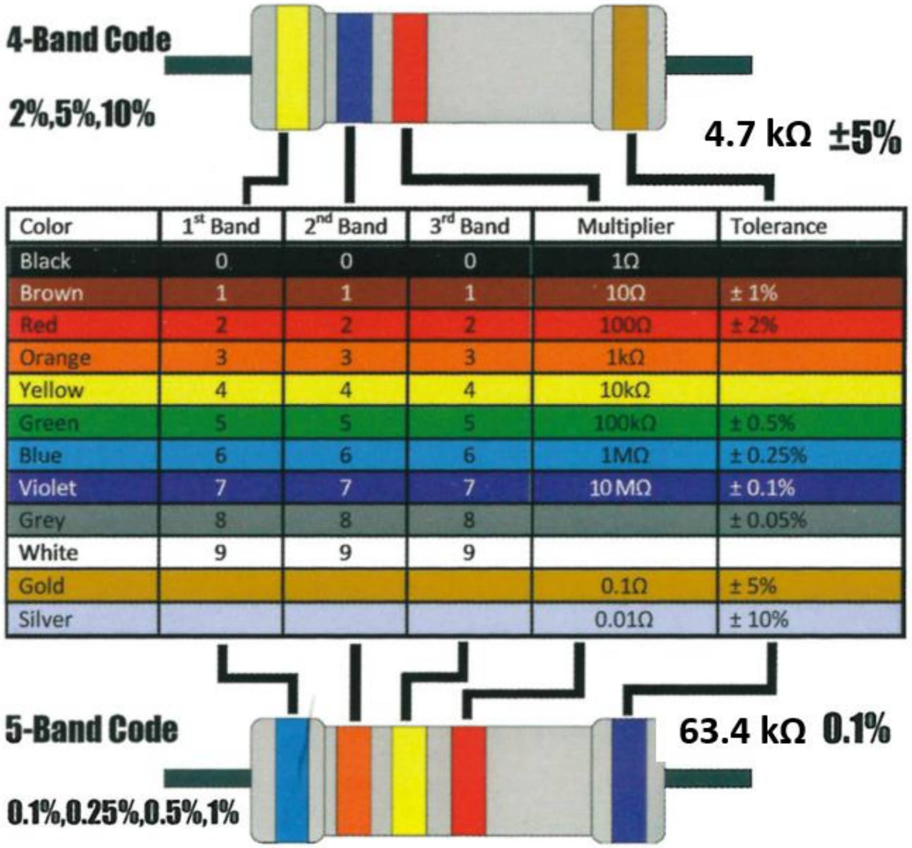
Procedure:

<u>Part 1. Identify and measure resistance</u>

<u>Step 1: Identify resistor values using color bands.</u>

- Using the resistor color band chart on the next page, **fill in the missing information** in the table below. (10 points)
  - *Note: high precision resistors (tight tolerance) have blue bodies and 5 color bands, while standard resistors have a brown body and 4 color bands.

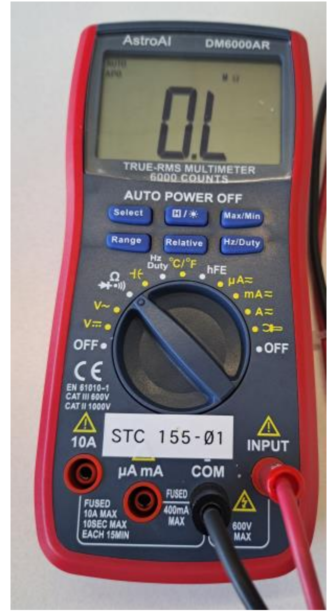
Resistor value	Tolerance limit	Body color	Band 1	Band 2	Band 3	Multiplier band	Tolerance band
Example: 430 Ω	1%	Blue	Yellow	Orange	Black	Black	Brown
2.7 KOhm	1%	Blue	Red	Violet	Black	Brown	Brown
1.0 MΩ	5%	Brown	Brown	Black	(none)	Green	Gold
10 kΩ	1%	Blue	Brown	Black	Black	Red	Brown
10 KOhm	5%	Brown	Brown	Black	(none)	Orange	Gold



Step 2: Calculate allowed tolerance.

- Grab a 10 kΩ resistor plus one additional resistor from the previous table. Ensure one of the resistors is a **precision (blue)** resistor and the other is a **standard (brown)** resistor.
- Calculate the allowed resistor value ranges for any two resistors. **Enter it in the table below**. (5 points)

Resistor value (ideal)	**Tolerance %**	**Calculated min resistance**	**Calculated max resistance**	**Measured resistance**	**Within tolerance? (yes/no)**
Example: 5 kΩ	*1 %*	*4950 Ω*	*5050 Ω*	*5010 Ω*	*yes*
R1: 10 kΩ	5%	9500	10500	9920	yes
R2: 11 KOhm	1%	10890	11110	10960	yes



Step 3: Measure the resistances.

- Configure the digital multimeter to measure resistance (see picture)
  - Set to "Ω"
  - Connect the black cable to "COM" and red to "INPUT"
- Measure the two resistors from the table above and **record the values in the table**. Are they within the specified tolerances? **Indicate in the table**.

Step 4: Measure the resistance of a thermistor.

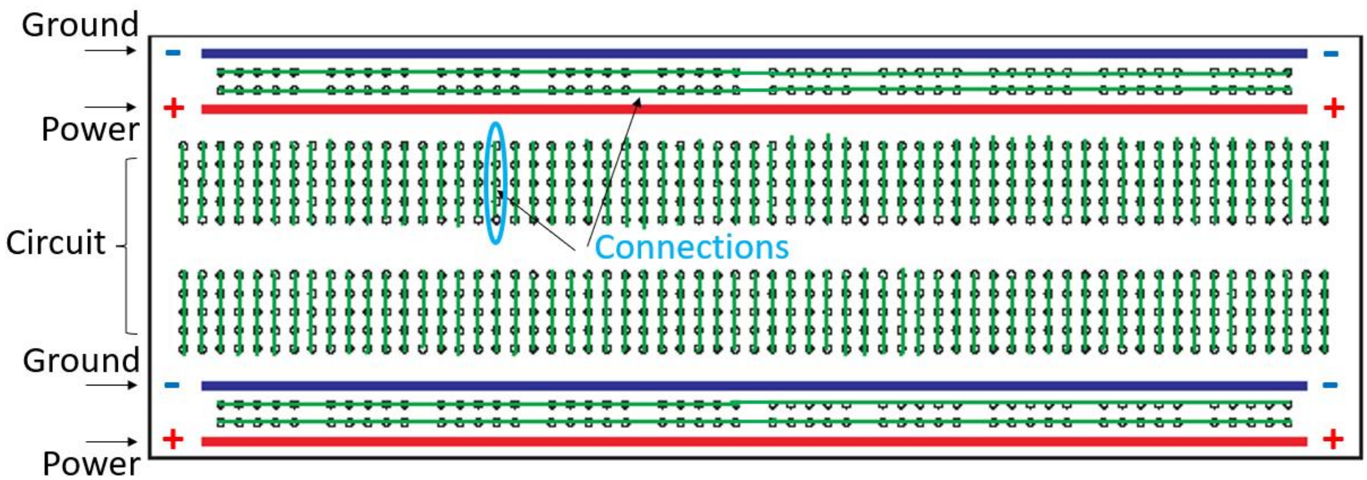
- Grab a two-terminal thermistor.
  - "NTC" thermistors have a negative temperature coefficient (resistance decreases as temperature increases)
  - "PTC" thermistors have a positive temperature coefficient (resistance *increases* as temperature increases)
- Measure and record the resistance of the thermistor at room temperature. (2 pts)
- Measure & record the resistance when the thermistor is pinched between your fingers. (2 pts)
- Is this a PTC or NTC thermistor? Thermistor type: NTC (1 pt)

Condition	**Measured resistance (in kΩ)**
Room temperature	9.7
Pinched between fingers	6.8

Part 2. Construct an electric thermometer circuit

Step 1: Learn breadboard connectivity.

- Study the breadboard diagram below.
- A green line indicates that these holes are connected to each other.
- The red "+" rows are conventionally used for power, while the blue "-" rows are for ground.
- The columns in the center are used for constructing your circuit.



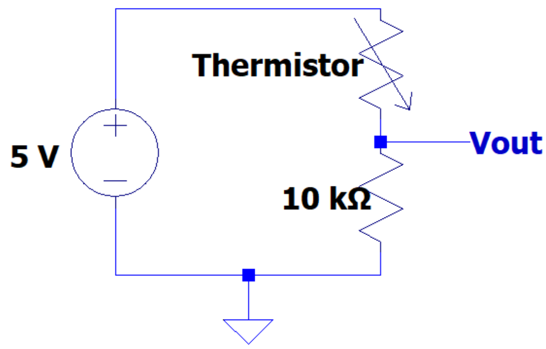
Step 2: Analyze the electric thermometer circuit.

- You are tasked with building a thermometer circuit in which the output voltage, Vout, **increases** as temperature **increases**. The schematic for this circuit is shown below.
  - **Question 1**: Using your measured results from the thermistor and your knowledge of Ohm's Law, do you expect the **current** through the circuit to *increase or decrease* as temperature **increases**? **Why**? (4 points)

(type answer here) Current should increase because the resistance to the current will decrease as temperature increases. A lower R in the numerator over V will give a lower I

  - **Question 2**: The voltage "Vout" is equal to the voltage across the 10 kΩ resistor. Using your answer from Question 1 as well as Ohm's Law, why will Vout increase as temperature increases? (Assume your thermistor is the same one you just measured) (4 points)

(type answer here) In the scematic, the resistance will stay the same but the current over the system will increase. So as I increases, and is multiplied by the same R, the V will increase



Step 3: Build the electric thermometer circuit.

- Build the circuit shown in Step 2.
- Measure the output voltage Vout at room temperature and with the thermistor pinched between your fingers. Use the digital multimeter in DC voltage mode. **Record the results**.
  - Reminder: the output voltage should increase with temperature.
- Calculate and record the temperature using your readings. Use the following equation:
  - TempF = 33.37 x Vout - 6.68

(8 points)

Condition	Measured Vout (V)	Calculated temperature (°F)
Room temperature	2.43 V	74.4
Pinched between fingers (*should increase temp)	2.94 V	91.4

*****To pass off your circuit, demo it to the TA or instructor and take Lab 2: Quiz 1*****

Part 3. Conclusions statement.

Write a brief conclusions statement that discusses all the original purposes of the lab. In doing so, please address the questions posed below. Please use complete sentences and correct grammar to express your thoughts on how you fulfilled the purposes of the lab:

Purposes (repeated):

- Be able to identify resistors using color bands and measure resistance with a multimeter.
- Understand resistor tolerances.
- Learn to use a breadboard.
- Apply resistors in a simple, useful circuit.

1. What do resistors do?
2. What is the difference between a resistor with a blue body and one with a brown body?
3. What functions of the digital multimeter did we use today?
4. How was a breadboard useful for building and analyzing this circuit?

Conclusions (10 points):

1. Resistors resist the flow of electricity meaning they lower the current while maintaining the same voltage.
2. The difference between a resistor with a blue body and one with a brown body is one with a blue body has 5 color bands and means it has a tight tolerance, meaning it can't vary as much as one with a brown body which has a low loose tolerance.
3. In the lab today we used both the resistance measuring function of the multimeter and the voltage measuring function.
4. A breadboard is useful for building and analyzing circuits because it has connected busses that you can easily plug in the components or jumper wires without a mess of clips and wires laying on the table, and you can also see easier what is connected to what on the breadboard.

Congratulations, you have completed Lab!
You may now submit this document.